Remarks of Victor Gilinsky
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I'm especially glad to be here today because I participated in the first such California Energy Commission hearing in 1977. I was then on the Nuclear Regulatory Commission. Both commissions were new to their jobs and we were feeling our way.

Your letter of invitation poses five questions: one about the NRC, another about the proposed Yucca Mountain waste repository, and others about alternative waste storage, reprocessing, and new nuclear technology. I will take these up in turn.

1. What are the major regulatory challenges for the NRC?

I'd say the biggest one is to act as an independent regulator and put public safety first. You'd think that wouldn't be a challenge because that's the NRC's statutory mandate. But in the last few years the NRC looks to me to be overly eager to please the nuclear industry. The agency's decision-making seems to have merged with that of the Nuclear Energy Institute. That doesn't seem healthy to me.

This approach dates from 1998. In that year the Senate Appropriations Subcommittee, chaired by Senator Pete Domenici, threatened NRC with severe budget cuts unless the agency became more accommodating to the industry. The then-NRC chairman quickly fell into line, and subsequent chairmen have stayed in line. This is not my interpretation. In his recent book Senator Domenici brags about forcing this change.[1]

[1] Senator Pete V. Domenici, *A Brighter Tomorrow: fulfilling the promise of nuclear energy*, Rowan & Littlewood, 2004, p. 75.

One result of the change was a more lenient NRC rating system for power reactor safety performance—it's a color-coded scheme, with "Green" as the top rating.[2] My reference point is the Davis-Besse plant in Ohio. In 2002 the plant was discovered to have had a narrow brush with a very severe accident. Over the previous several years, because of poor plant safety practices, its pressure vessel corroded badly and would not have lasted much longer had the plant gone back into operation. Yet just before this discovery the NRC gave the plant a perfect rating, all "Green" in 18 categories. So far as I can tell the NRC has not yet adequately dealt with this shortcoming.

2. What is the status of the Yucca Mountain Project and what are the lessons learned?

I should tell you right off that I've been a consultant for Nevada on Yucca Mountain issues for the past few years and that experience has colored my views. I've been involved with nuclear waste issues for a much longer time long time, of course.

When I addressed this Commission nearly 30 years ago, the federal government had just decided to bury nuclear waste deep underground. Before that, the plan was to put the waste in an engineered surface facility. The real reason for the shift to permanent disposal was not public safety. It was to demonstrate that there was a "permanent solution" to the waste problem, and thereby to protect nuclear power plant licensing from court challenge by environmental organizations. It was supposed to be cheap, but in time the project became hugely expensive and took on a life of its own.

Back in 1977 the date for opening a repository was supposed to be 1985. That has slipped and slipped until today DOE no longer has a date for opening Yucca Mountain.

[2] This replaced detailed NRC assessments that the industry didn't like.

The last mentioned date was 2015. In other words, in 30 years the nuclear waste repository has slipped more than 30 years.

But things are worse than that. Senator Domenici—a strong project supporter—described the Yucca Mountain repository as an "expensive black hole."[3] It's an apt description. Despite enormous expenditures and heavy political backing, the project is in deep trouble. It is caught up in a mess of technical, legal, and managerial problems. I don't think it will ever open.

DOE was able to get this far because it hasn't faced independent scrutiny. The supposedly independent federal regulators, the Environmental Protection Agency and the NRC, have been acting as if they were part of the same team.[4] EPA and NRC both lowered their own standards in promulgating rules specifically for Yucca Mountain.[5]

In July 2004 the federal Court of Appeals, which really is independent, tossed out EPA's standard because it clearly didn't comply with the law.[6] That invalidated NRC's licensing standard, as well. Last week EPA proposed a new standard that in its essentials hardly differs from the first. I expect the case will go back to court.

In August 2004 a panel of NRC administrative judges—who have some separation from commissioners and staff—handed DOE another setback. They threw out DOE's formal certification that it had made public the documents it was supposed to six

[3] Domenici, p. 221.
[4] The EPA sets the basic radiation protection standard for the project and the NRC applies it in licensing.
[5] DOE, also, has much tighter siting criteria for waste repositories in general than it applied at Yucca Mountain.
[6] US Court of Appeals, District of Columbia Circuit, July 9, 2004, NEI v. EPA.

months in advance of filing a license application.[7] DOE's violation of NRC's document regulations was blatant and deliberate; the Department has yet to comply with this ruling.

DOE blames both the federal court's action and that of the NRC judges for its delay in filing an NRC license application—scheduled for December 2004. The Department also blames inadequate funding from Congress. My own view is that DOE wasn't ready last December with a credible application. And when it comes to money, DOE's problem is not that it was getting too little but that it was getting too much, and spending it without adequate controls.

Senator Domenici's description of Yucca Mountain as an "expensive black hole" is apt in another respect. While making a great show of openness, DOE is obsessively secretive. That doesn't bode well for the public's health and safety.

There are many lessons here. Let me just point to one. Once Congress narrowed site evaluation to *one site*—as it did in 1987—it was unrealistic to expect that Yucca Mountain would get a fair evaluation. When DOE learned of the site's problems—mainly lots more water, and moving faster, than expected—it should have returned to Congress and pronounced the site unsound. But too many bureaucratic careers and too much contractor money were at stake. The so-called "good science" that DOE says supports its case is, to my mind, more in the nature of litigation support. That is quite different from real scientific investigation that asks all the hard questions.

3. What are the trade-offs between "interim" storage vs. permanent waste disposal?

[7] "NRC licensing board issues decision on adequacy of DOE document production relating to Yucca Mountain licensing proceeding," NRC press release, August 31, 2004.

Storage at surface or near-surface facilities is simpler, cheaper, and allows for correction of problems, such as defects in the waste containers. But it requires continual monitoring. So-called permanent geologic disposal eventually does away with the monitoring but it is hugely expensive and after some point mistakes are *irretrievable*. That would likely be soon after the radioactive spent fuel was placed in Yucca Mountain's underground tunnels.

In the light of Yucca Mountain's problems, the federal government should rethink its nuclear waste management plan—*we need a Plan B*. The urgent task is to get the existing spent fuel bundles out of water pools adjacent to reactors and into "dry casks"—large, reinforced air-cooled concrete vessels. This can be done with all but the hottest, most recently withdrawn spent fuel (which will, anyhow, always stay at the reactors). Almost thirty sites are NRC-approved for cask storage. For the longer term, we should collect the spent fuel at *regional central storage sites* at or near the surface.

4. What is the current status of spent fuel reprocessing domestically and internationally?

Reprocessing is of course the chemical separation of the spent fuel into its components, principally uranium, plutonium, and the highly radioactive fission products. There is no commercial reprocessing in the United States, mainly because it makes no economic sense. There are commercial reprocessing plants in Britain and France that operate on a subsidized basis. Japan has built a new reprocessing plant that is supposed to

start up next year.[8] The plant is so expensive that Japan will pay several *times* more for a fuel rod using recovered plutonium than they pay for a fuel rod using enriched uranium.

To understand why nuclear establishments—including our own—are pulled in this uneconomic direction, we need a little history. At the start of the nuclear age, uranium was thought to be scarce and reprocessing cheap. The original plan was to use uranium-burning reactors of the sort we have today to make plutonium, and then to use that to start a new generation of plutonium-fueled "fast breeder reactors" that would in effect "breed" their own fuel. It's a beguiling concept, but for now it is one far removed from economics and practicality.[9] Uranium is plentiful and spent fuel reprocessing is very expensive. Fast breeder reactors are nowhere near economic, either. But none of this matters to the true believers.[10] They are thirsting to get back to the original dream.

There is also another motive for the new push for reprocessing. You have to remember that just because something is uneconomic doesn't mean there isn't money in it—so long as the government mandates it and somebody foots the bill. If we follow the French and Japanese down this uneconomic path the US taxpayer will take a big hit.

5. What is the status of new nuclear energy technologies and alternative fuel cycles?

As this is a large subject, let me concentrate on an alternative to nuclear waste disposal that DOE has been funding. It goes by the name of waste transmutation. The

[8] *Nuclear Energy Data*, OECD, 2005, p. 54, gives the French, British, and Japanese reprocessing capacities.
[9] Fast reactors are so called because they operate on fast neutrons.
[10] They still beat up on Jimmy Carter for stopping US reprocessing in 1976. Senator Domenici, at p. 116, says: "The Carter administration decision to pursue the open fuel cycle [no reprocessing and recycling of plutonium] may stand as one of the worst and most damaging in the last thirty years of U.S. nuclear policy." The well-thought out 1976 decision was actually made by the President Gerald Ford on security grounds—plutonium is a nuclear explosive—just before Jimmy Carter was elected. If nothing else, the decision saved the United States an enormous amount of money.

underlying idea stems from the observation that nuclear waste falls into two groups. The first is fission products—the remnants of split uranium nuclei—which are highly radioactive but whose radioactivity ceases to be of concern in less than a thousand years. The other group contains plutonium and other heavy elements—whose radioactivity is less intense but which does not diminish significantly for up to a million years. If you could burn up the heavy elements in reactors, you would reduce the long-term waste problem to a thousand-year problem, until the fission products decay. The plan is to leave them on the surface and thus eliminate the need for any more underground repositories. Ordinary reactors can burn plutonium, but it takes fast neutrons to burn the other heavy elements, so waste transmutation has become an argument for developing fast reactors.[11]

The nuclear gurus behind this believe that if the public thought nuclear waste was only a thousand year problem they would be much more receptive to nuclear plants. (I get this, by the way, from having served on the DOE research subcommittee that supervised the transmutation program.) The problem is that the needed technologies are undeveloped, and in any case promise to be enormously expensive.

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Let me end on a positive note. The operators of almost all of the hundred or so US nuclear plants, including the California operators, have learned from practical experience and are performing well. If we take an equally practical approach to nuclear waste we can develop a workable Plan B that will protect both the public's health and its pocket book.

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[11] Three of the five advanced reactor designs (so-called Generation IV) that DOE is pursuing are fast reactors that are justified on the grounds that they "will enable more effective management of actinides [heavy elements] through recycling of most components in the discharged fuel." (http://gen-iv.ne.doe.gov/GENIVPriorities.asp) Except for the new rationale, the DOE advanced reactor program bears a strong similarity to the Atomic Energy Commission's fast reactor program of the 1960s.